

PERIODIC REPORT No.6

Contract NAS5-98046

Period covered: 12 May 2000 - 21 December 2000—

Prepared for  
NASA/Goddard Space Flight Center

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During the current reporting period we continued work on the task T1 described in section E.2.1 on page 2 of our UARS NRA proposal 'CLAES product improvement by use of the GSFC Data Assimilation System (DAS)'. This 1st task is to plug line of sight gradients derived from the CTM for 2/20/92 into the forward model of our retrieval software (RSW) in order to assess the impact on the retrieved quantities. We are currently nearly finished with this task as we will describe in the present report #6.

In the next reporting period we can work in parallel on completing task T1, and in beginning our second task T2, namely:

- Demonstrate the improvement in retrieval of  $\text{CH}_4$  and  $\text{N}_2\text{O}$  over the time period 18 to 25 February 1992 that is achieved by coupling the GEOS-DAS and the CLAES RSW.

#### Review of report #5:

In review, during the previous reporting period we had focussed on

1. Integrating the CTM data reader that was provided by the DAS personnel into our retrieval SW, and
2. including the CTM gradients in the retrieval of CLAES temperature, which is input for  $\text{CH}_4$  retrieval

Regarding item 1: During this period the DAS personnel developed and delivered a CTM data reader to the specifications described above. Then we made 2 modifications in the CTM data reader. The first to account for the differences in our vms system vs the DAS unix system. The second to make it run fast. While implementing the second modification, we found and corrected a mistake in our 4th period work.

Regarding item 2: The EMAF 46914540 CTM temperature gradients and the baseline NMC gradients are compared on figure 1. In this figure a positive gradient increase along the direction from the tangent

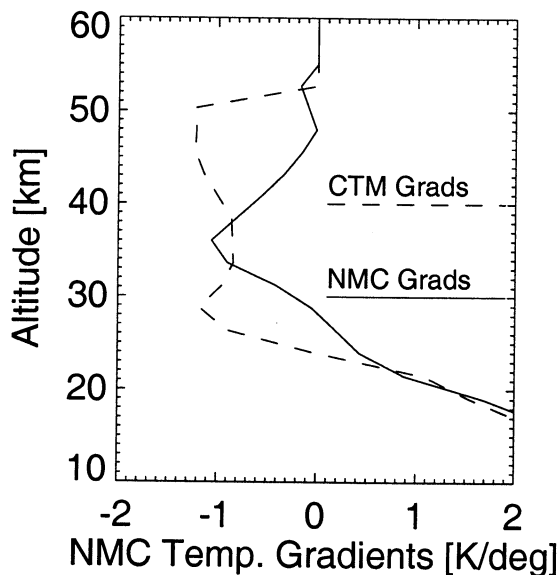


Figure 1 CTM vs NMC temperature gradients for EMAF 46914540

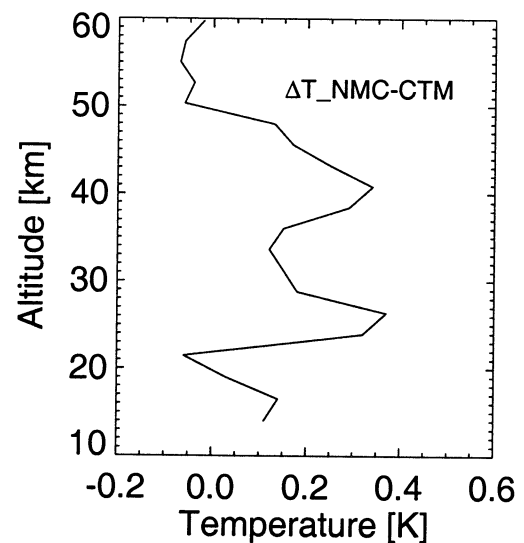


Figure 2 difference in temperature retrieval due to using CTM vs NMC temperature gradients for EMAF 46914540

point to the UARS spacecraft, and the units are K/degree of great circle arc. The major difference in the two sets of temperature gradients is the altitude where the sign changes. The difference in temperature when using CTM gradients in its retrieval vs NMC is shown on figure 2.

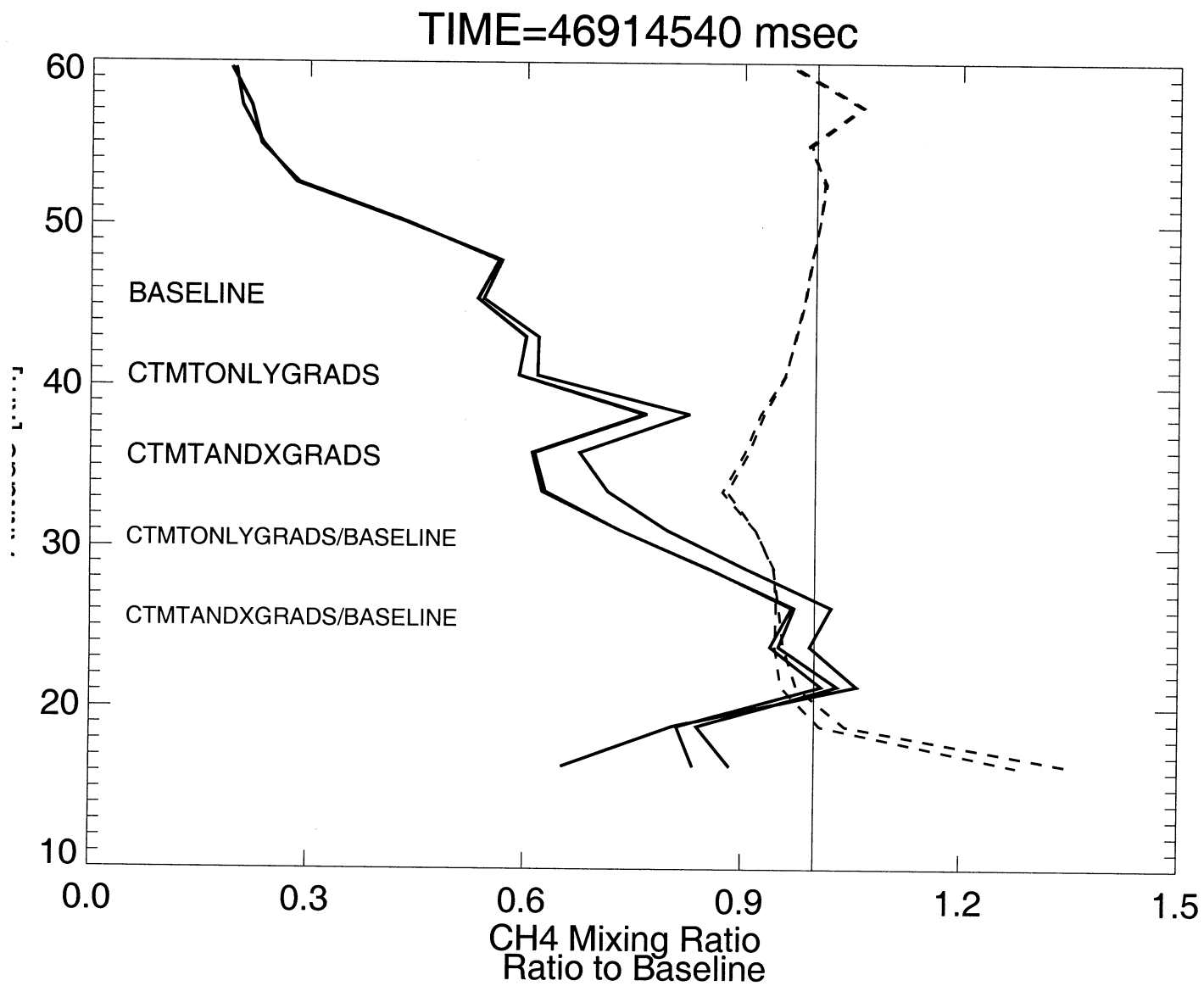
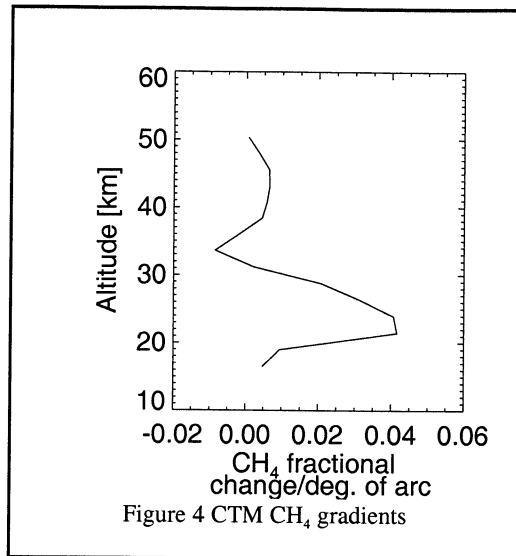


Figure 3 CH<sub>4</sub> retrieval comparisons for EMAF 46914540



Next, the retrieval for CH<sub>4</sub> for the EMAF at 46914540 is shown on figure 3. This is similar to figure 1 in the report #4, but with corrections as were described in report #5. The black curve is the baseline temperature used in the retrieval. The baseline CH<sub>4</sub> forward model uses NMC temperature gradients and zero CH<sub>4</sub> gradients. The red curve CTMONLYGRADS is computed with the CLAES baseline temperature modified as in figure 2 by use of CTM gradients, and the CTM temperature gradients also used in the CH<sub>4</sub> retrieval forward model. But zero CH<sub>4</sub> gradients are used in the CH<sub>4</sub> model. The green curve CTMTANDXGRADS is computed with CTM input as is CTMONLYGRADS, but also include the CTM CH<sub>4</sub> gradients. These are shown in figure 4. The broken red curve shows the ratio of CTMONLYGRADS to the baseline, and the broken blue curve is the ratio of CTMTANDXGRADS to the baseline. It is seen here that the CH<sub>4</sub> gradients make some difference at low altitudes.

### The current reporting period work:

During the current reporting period we have implemented the retrieval using the CTM temperature, CH<sub>4</sub> and N<sub>2</sub>O gradients for the entire day 162 and will discuss the results here.

### Zonal mean comparisons:

Zonal means of baseline retrieved CH<sub>4</sub> and retrieved by use of forward model that includes CTM temperature and species (CH<sub>4</sub>, N<sub>2</sub>O) horizontal gradients are compared on figures 5 and 6. These are labeled CTMTANDXGRADS and BASELINE, respectively. Two obvious things we learn from these are

- 1 there is little difference in a zonal mean sense in the retrieved product

- 2 The CTMTANDXGRADS is spiky at the high altitudes. So before we commence with a joint retrieval that couples the GEOS-DAS and the CLAES RSW, we need to fix the 'spikiness problem'. It probably can be traced to a few EMAS. There may also be some 'spike' problems at the lower altitudes.

Next on figures 7 & 8 are shown comparisons of CTMTANDXGRADS and CTMONLYGRADS which again show there is some small difference on including the CH<sub>4</sub> gradients, even in the highly averaged case of the zonal mean. Finally on figures 9 and 10 the N<sub>2</sub>O CTMTANDXGRADS and BASELINE zonal mean comparison is shown. There are differences reminiscent of the CH<sub>4</sub> case as discussed above.

### Surface maps:

The CH<sub>4</sub> CTMTANDXGRADS and BASELINE 6.8 mb maps are shown on figures 11 through 14, and CTM that we have mapped (first into 3A file format) on 6.8 mb on figures 15 and 16. Major points are:

- 1 The CLAES retrievals show much more ascending to descending difference than does the CTM
- 2 the CLAES products show an enhanced band going from zero longitude & 50N, to about 100 longitude and 70N that is not present in the CTM, the CLAES north projecting enhancement at about 260 longitude is displaced towards about 220 longitude in the CTM, and more enhanced. There is a small common northward projecting enhancement common to CLAES and CTM at ~ 130 longitude. In CLAES this latter seems more to be part of the major enhancement emanating from zero longitude towards the northeast.

Points 1 and 2 are supported by maps of N<sub>2</sub>O on the 6.8 mb surface that, for brevity, are not shown here.

Next the CH<sub>4</sub> CTMTANDXGRADS and BASELINE 3.1 mb maps are shown on figures 17 through 20, and CTM (as above) on 3.1 mb on figures 21 and 22. Major points are:

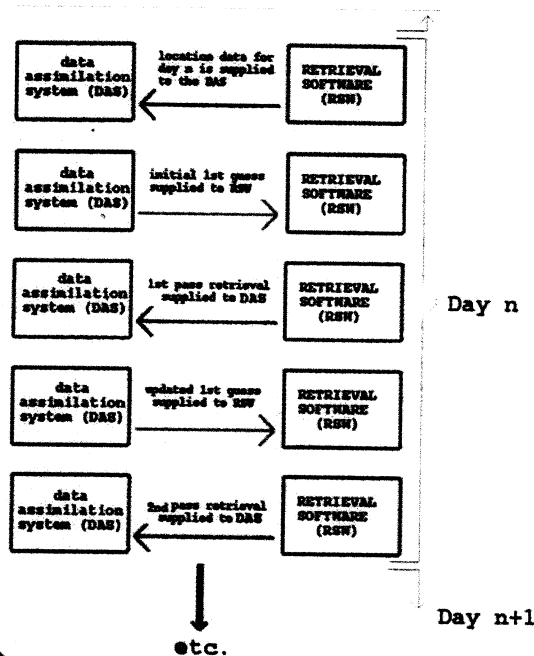
- 1 generally the CTM has smaller values now than the CLAES products
- 2 the CTM & CLAES morphology look more alike at 3.1 mb than at 6.8 mb
- 3 the relative enhancement of the feature protruding to the northeast from about zero long & 40N (call it F1), and of the feature protruding almost due north at about 100 long (call it F2) has reversed. The feature centered at about 200 long and 70N (call it F3) now clearly appears to be an extension of the feature F2 that goes on across the polar region.
- 4 The CTMTANDXGRADS has noticeably less ascending to descending difference than does the BASELINE

Next the  $N_2O$  CTMTANDXGRADS and BASELINE 3.1 mb maps are shown on figures 23 through 26, and CTM (as above) on 3.1 mb on figures 27 and 28. These are very consistent with the conclusions drawn with regard to  $CH_4$  as discussed above.

### Continuing study:

There are several areas of further study that would prove very productive

We are now at the point where we can set and run the DAS and the CLAES retrieval SW together (as in figure 1 from the original proposal, below) so the gradients will be based on the morphology of the CLAES data, and not on the CTM.



Prior to running with the DAS & CLAES RSW we need to study will focus on

- clean up the high altitude 'spikiness' in the CTMTANDXGRADS
- identify candidate mechanisms for producing the ascending to descending differences in CLAES data

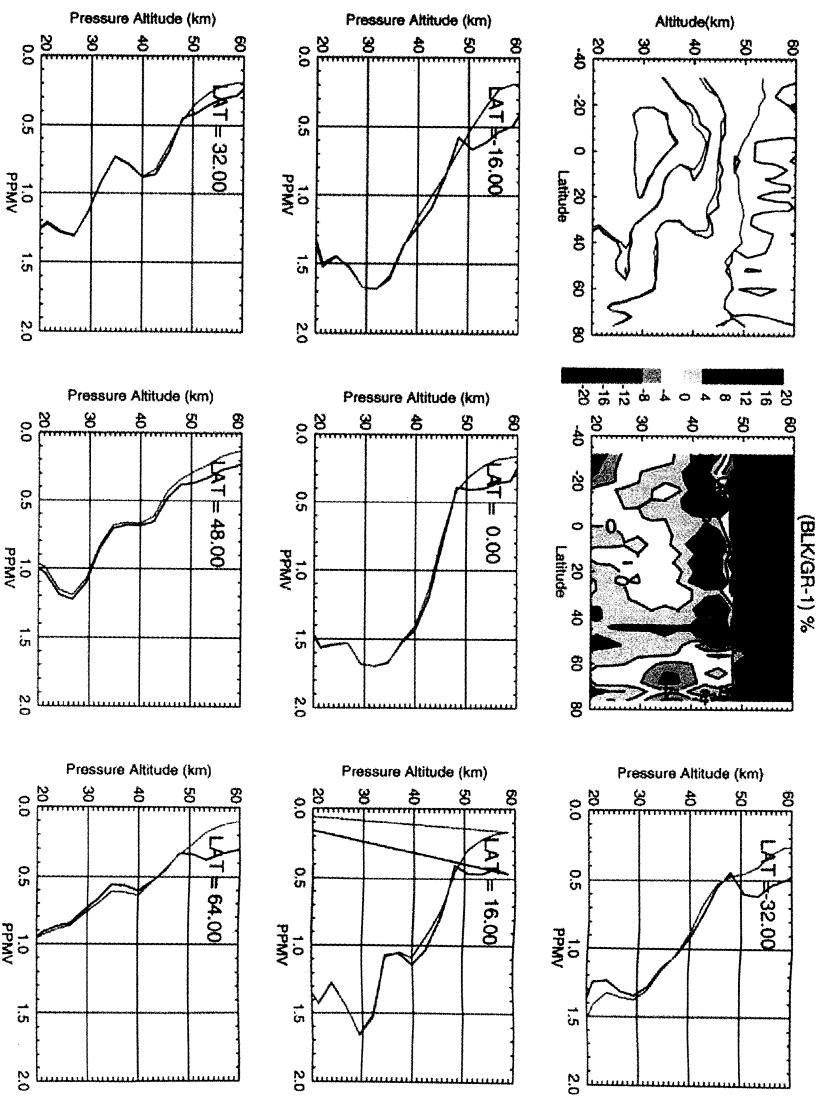
Considering the latter, we know that there are portions of the CLAES retrieved  $H_2O$  where this is a pathological case. A solution for the condition as with  $CH_4$  &  $N_2O$  might also help to solve that problem for  $H_2O$ .

It would be interesting to exercise the capability to use the CTM gradients that we have developed so far for  $H_2O$ , to assess how gradients might influence that problem.

Also, we plan to discuss results to date with our DAS Co-Is, and with our contract monitor Anne Douglass to sharpen our focus on the work we will do in finishing this effort.

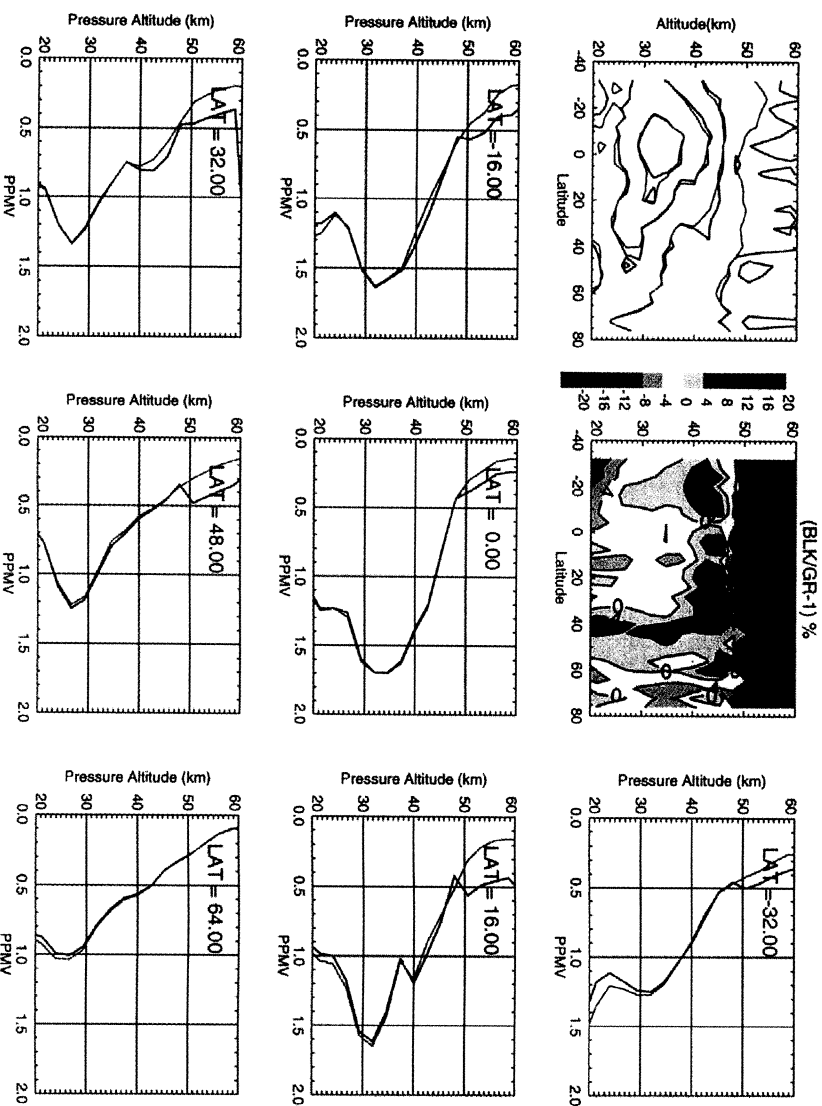
CTMTANDXGRADS\_ASC\_D162

BASELINE



CTMTANDXGRADS\_DSC\_D162

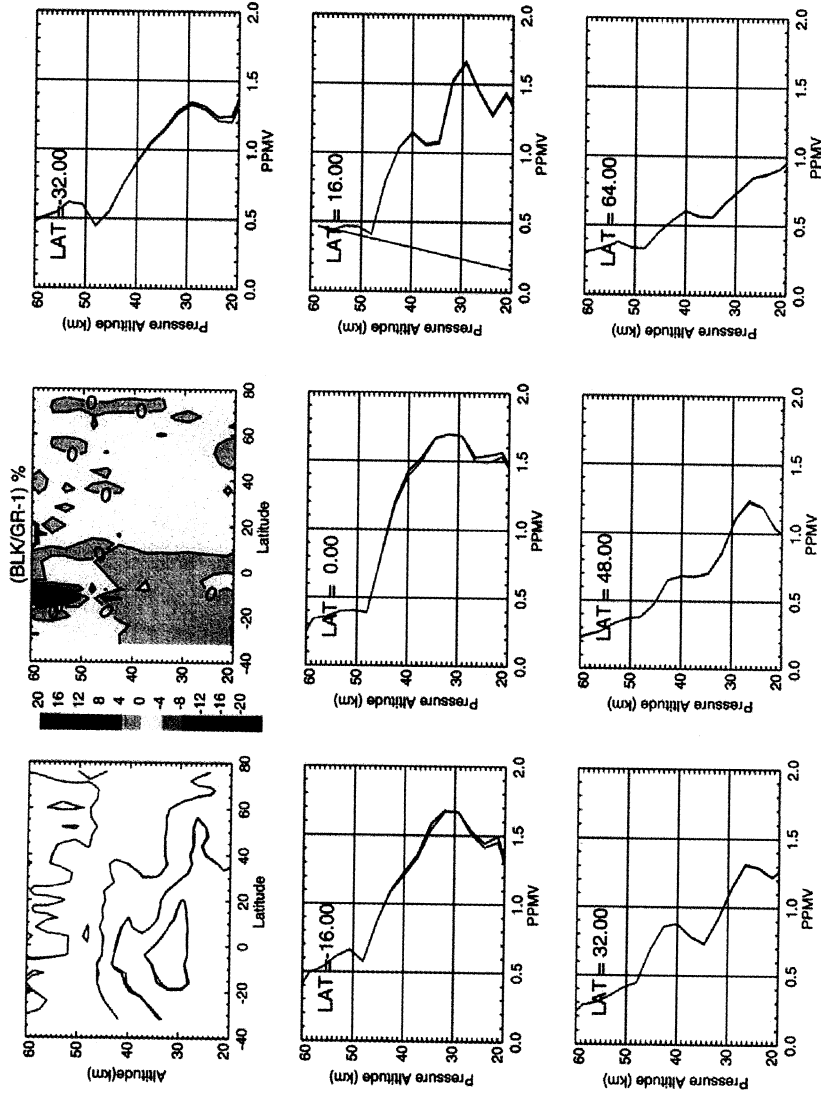
BASELINE



Figures 5 and 6 CH<sub>4</sub> zonal mean comparison CTMTANDXGRADS and BASELINE

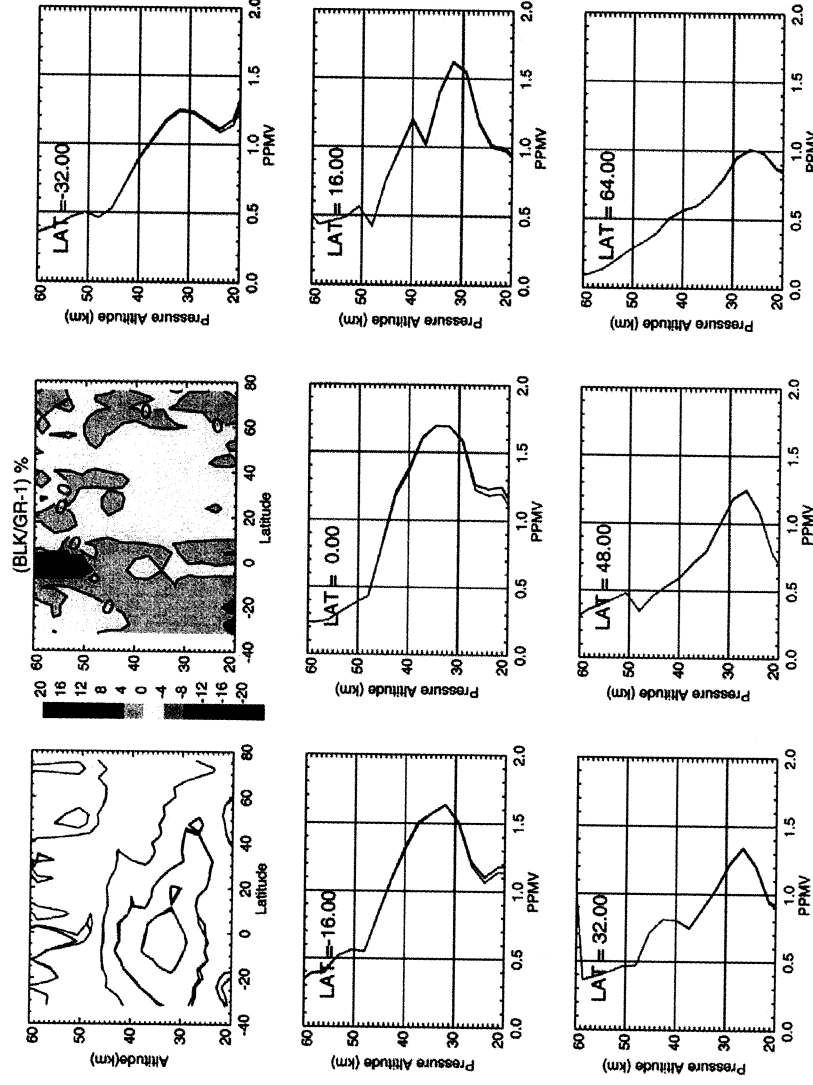
# CTMTANDXGRADS\_ASC\_D162

CTMTONLY



# CTMTANDXGRADS\_DSC\_D162

CTMTONLY

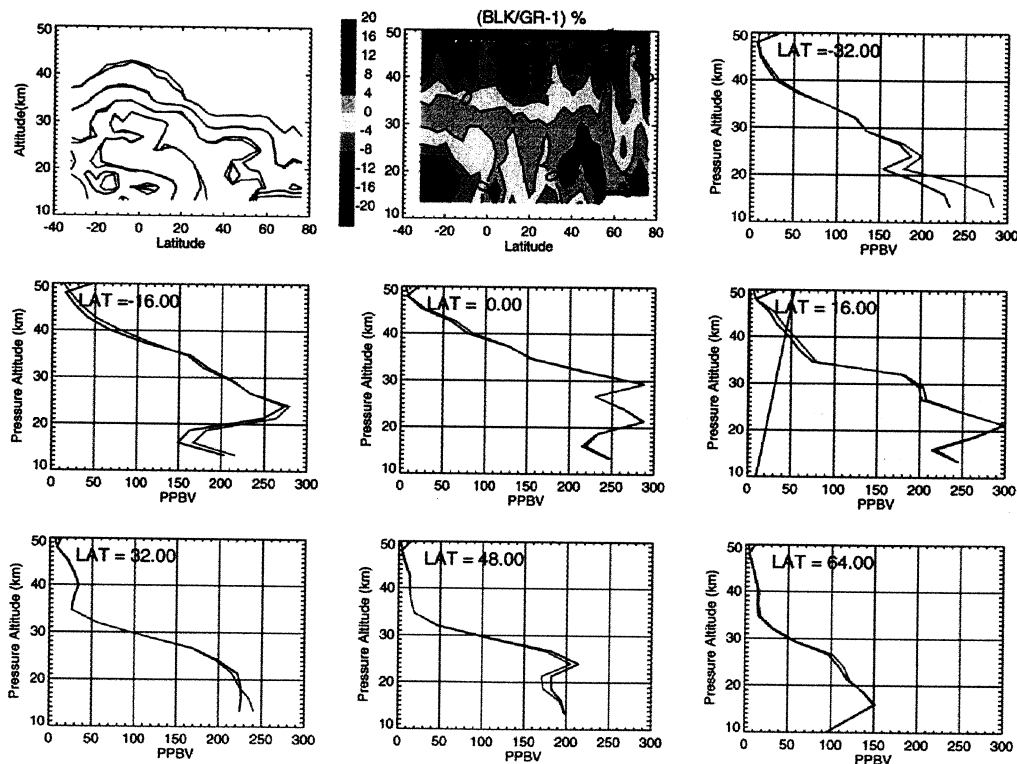


Figures 7 and 8 CH<sub>4</sub> zonal mean comparison CTMTANDXGRADS and CTMTONLY



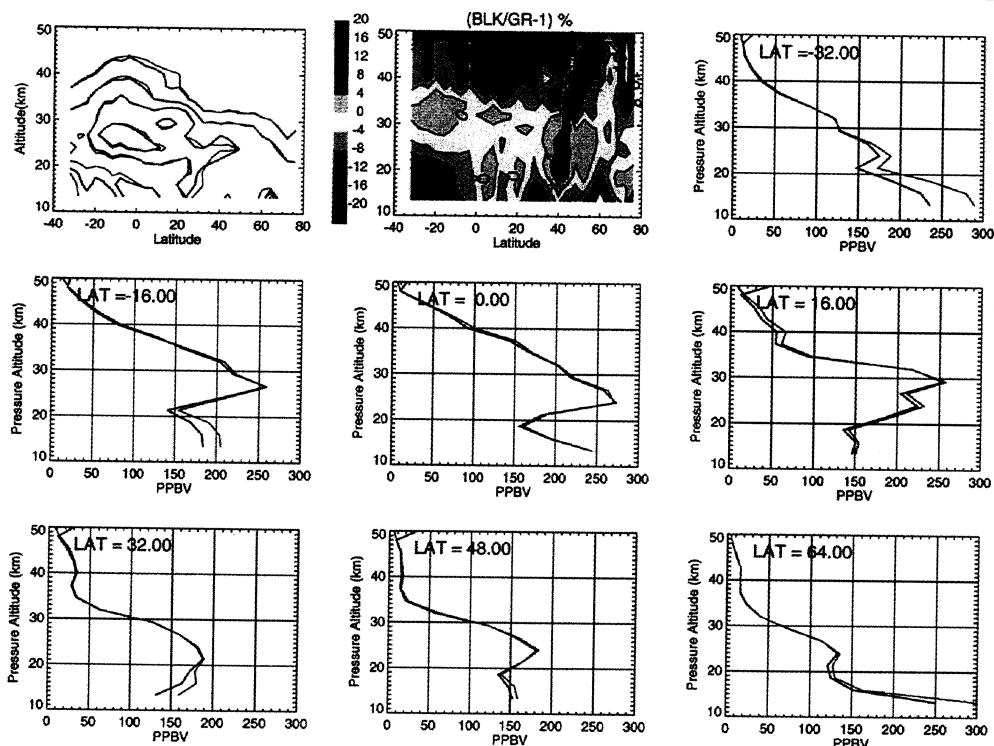
# CTMTANDXGRADIENTS\_ASC\_D162

# BASELINE



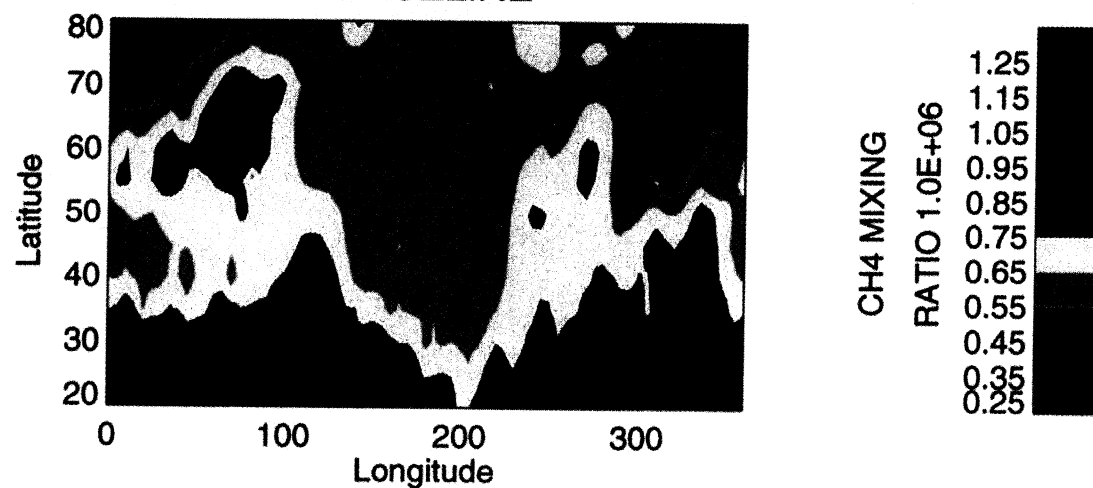
# CTMTANDXGRADIENTS\_DSC\_D162

# BASELINE

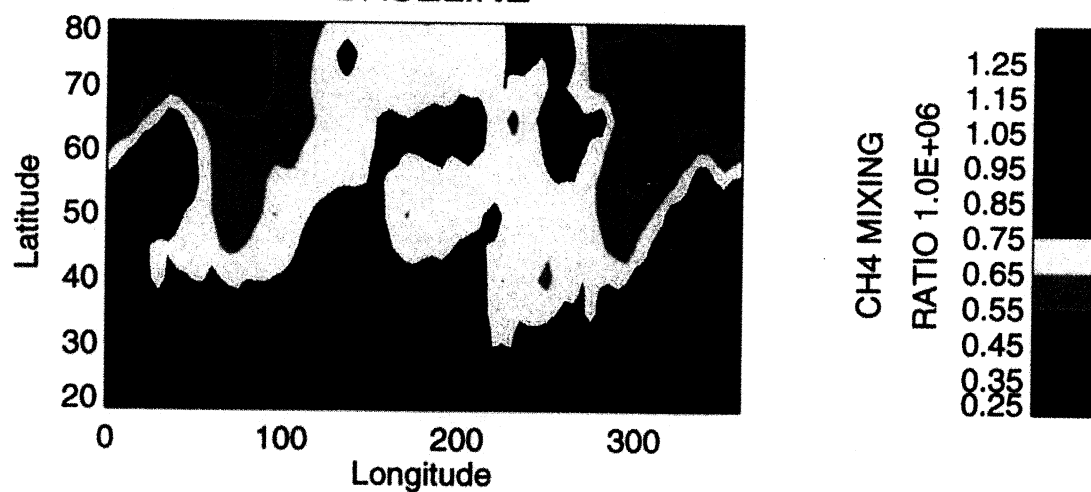


Figures 9 and 10 N<sub>2</sub>O zonal mean comparison CTMTANDXGRADS and BASELINE

CLAES CH<sub>4</sub> @6.8hPa on 20-Feb-1992 ascending  
 BASELINE

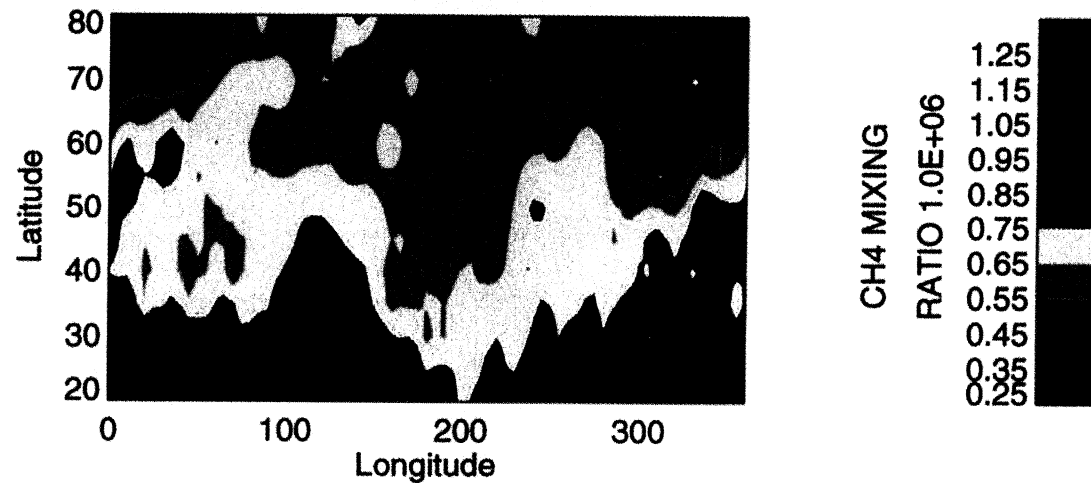


CLAES CH<sub>4</sub> @6.8hPa on 20-Feb-1992 dscending  
 BASELINE

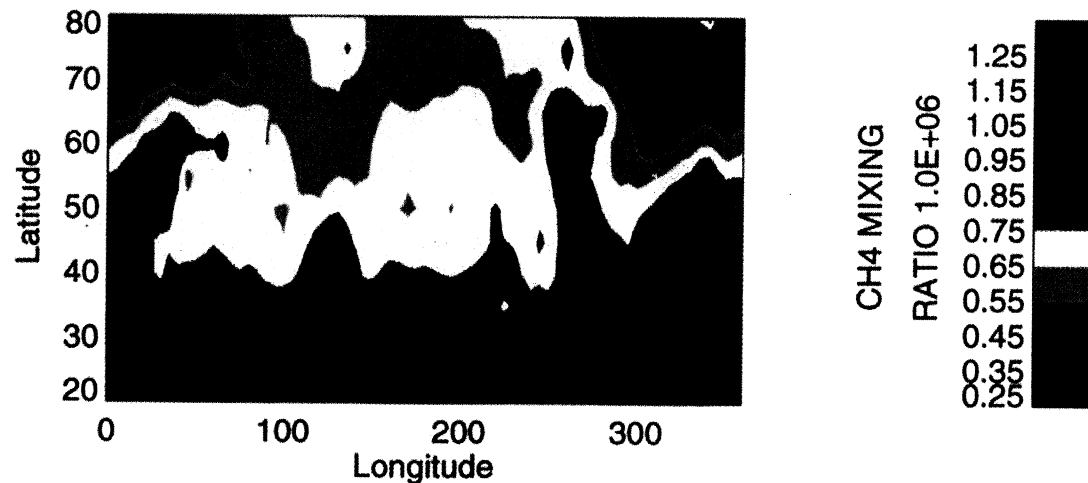


Figures 11 and 12 CH<sub>4</sub> baseline on 6.8 mb

CLAES CH4 @6.8hPa on 20-Feb-1992 ascending  
CTMTANDXGRADIENTS

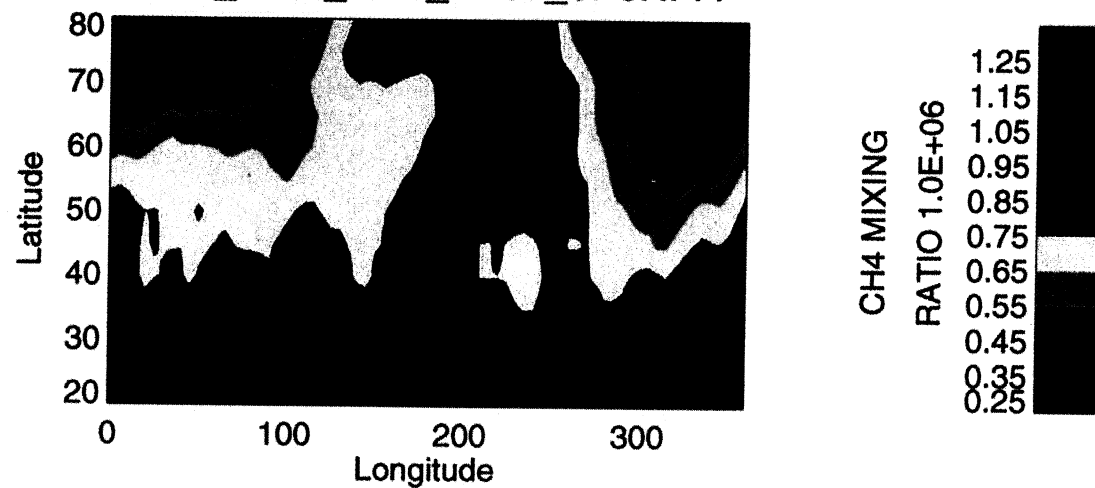


CLAES CH4 @6.8hPa on 20-Feb-1992 dscending  
CTMTANDXGRADIENTS

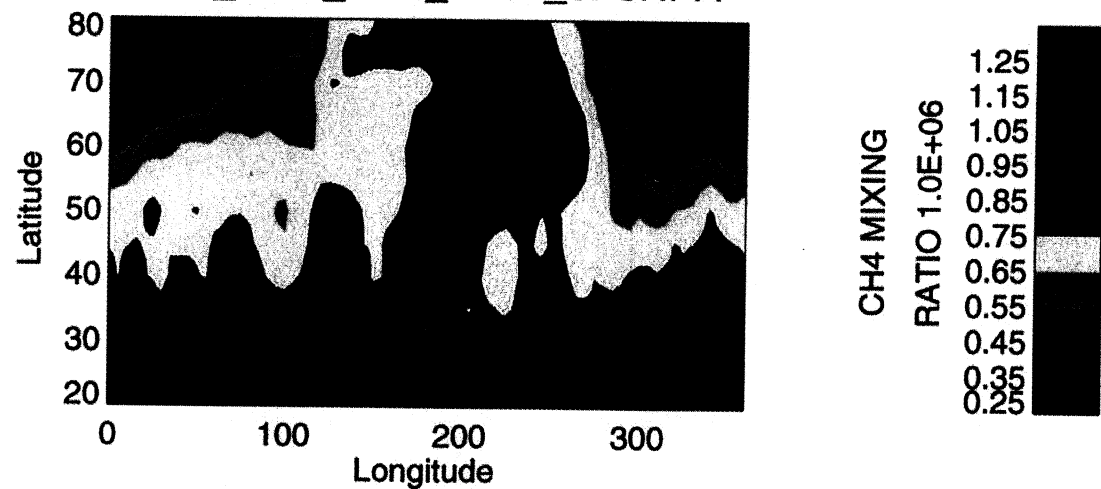


Figures 13 and 14 CH<sub>4</sub> CTMTANDXGRADS on 6.8 mb

CLAES CH<sub>4</sub> @6 hPa on 20-Feb-1992 ascending  
3AT\_CTM\_CH<sub>4</sub>\_D162\_6P8HPA

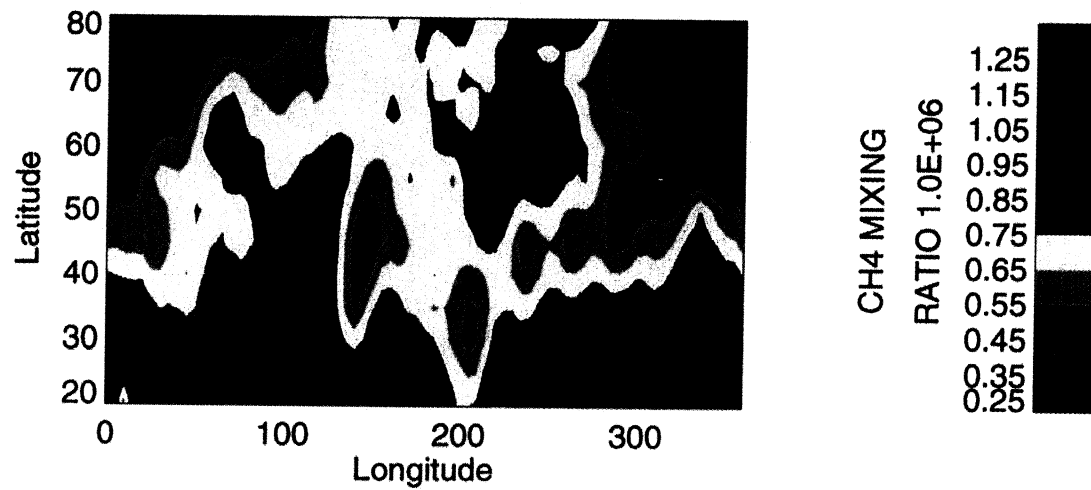


CLAES CH<sub>4</sub> @6 hPa on 20-Feb-1992 descending  
3AT\_CTM\_CH<sub>4</sub>\_D162\_6P8HPA

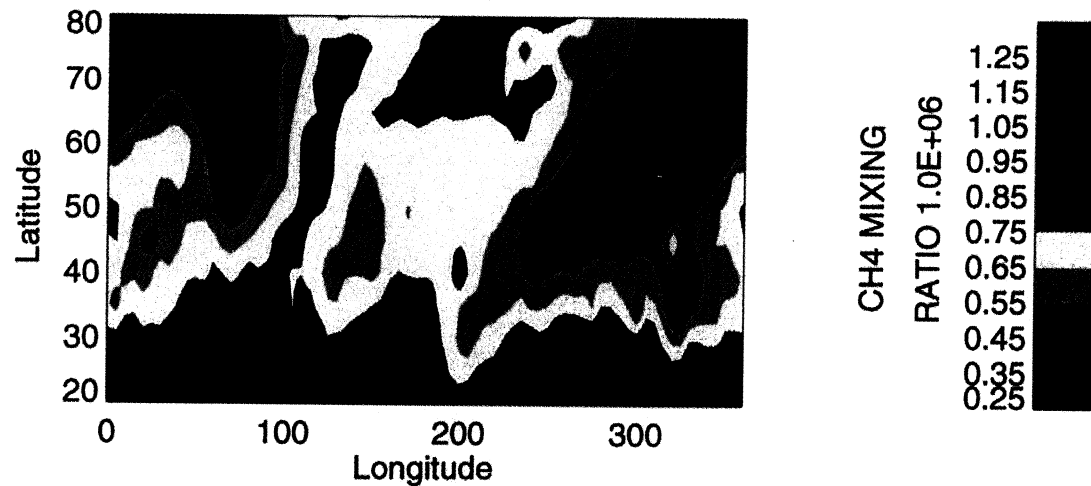


Figures 15 and 16 CH<sub>4</sub> CTM on 6.8 mb

CLAES CH<sub>4</sub> @3.1 hPa on 20-Feb-1992 ascending  
BASELINE

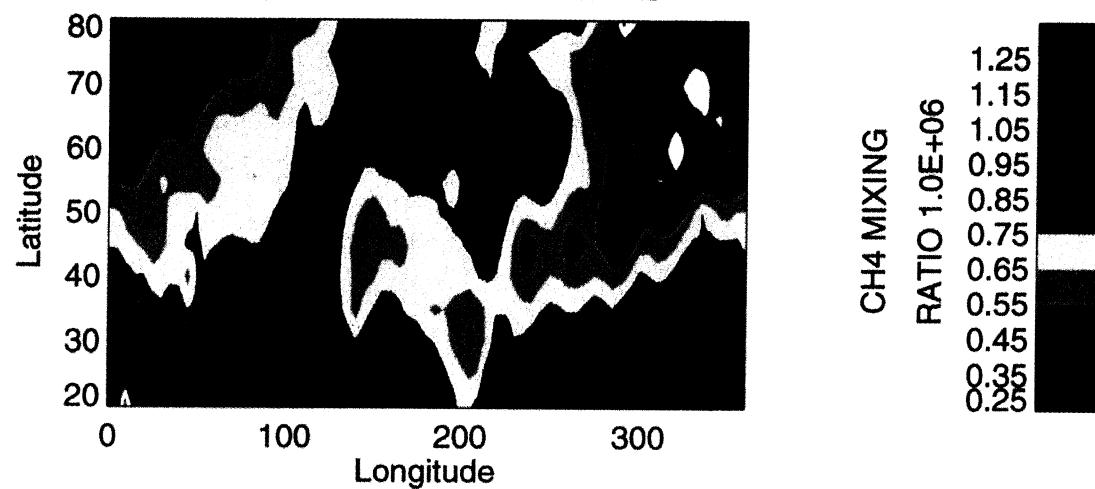


CLAES CH<sub>4</sub> @3.1 hPa on 20-Feb-1992 dscending  
BASELINE

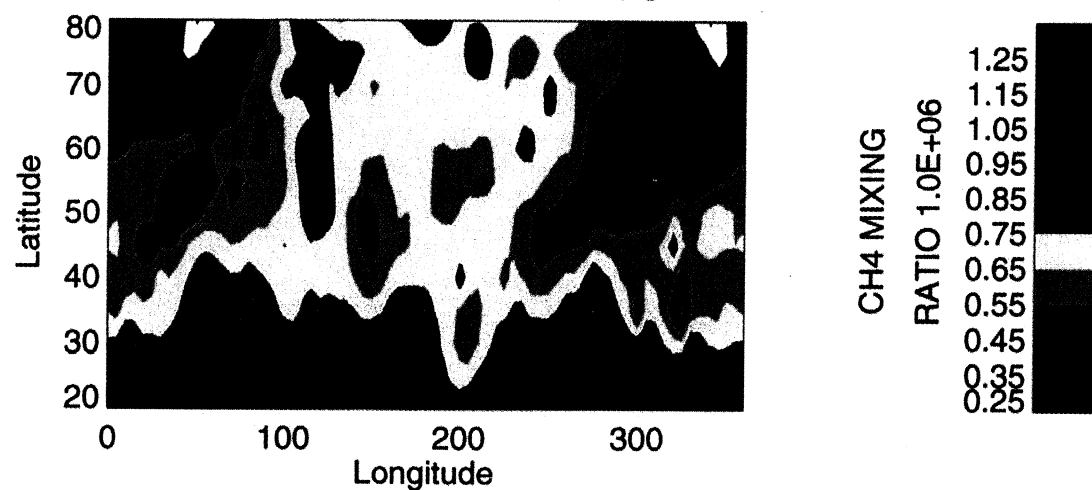


Figures 17 and 18 CH<sub>4</sub> baseline on 3.1 mb

CLAES CH<sub>4</sub> @3.1 hPa on 20-Feb-1992 ascending  
CTMTANDXGRADIENTS

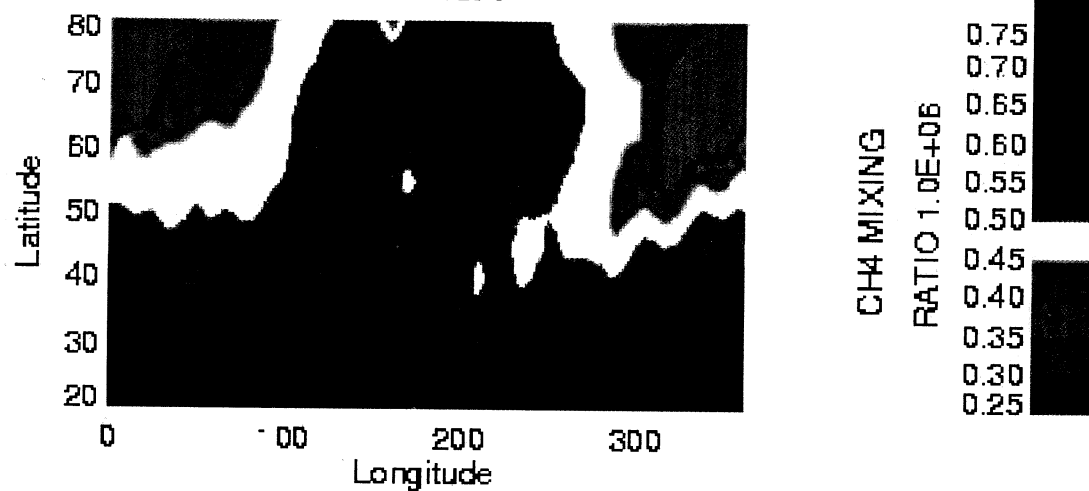


CLAES CH<sub>4</sub> @3.1 hPa on 20-Feb-1992 dscending  
CTMTANDXGRADIENTS

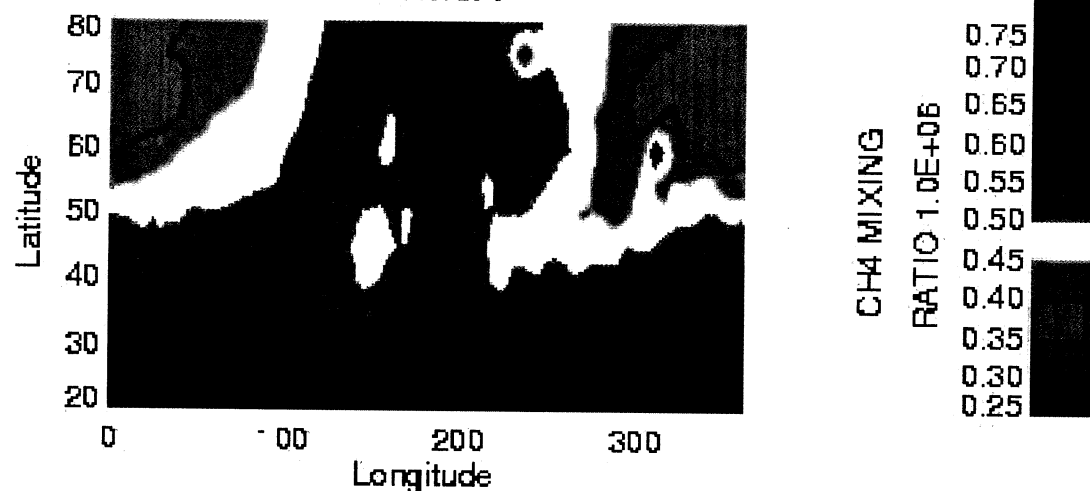


Figures 19 and 20 CH<sub>4</sub> CTMTANDXGRADS on 3.1 mb

CLAES CH<sub>4</sub> @3.1 hPa on 20-Feb-1992 ascending  
CTM3A

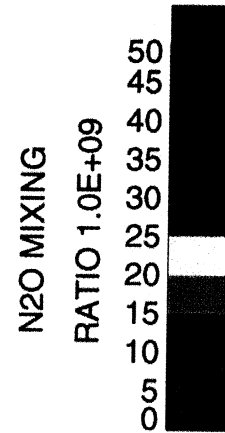
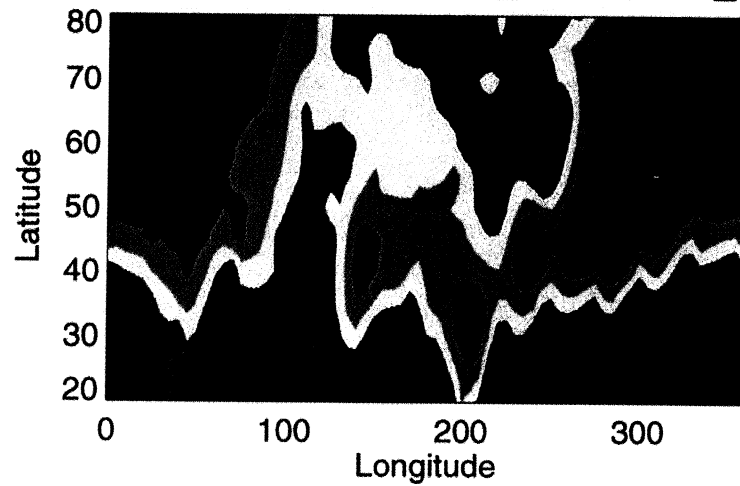


CLAES CH<sub>4</sub> @3.1 hPa on 20-Feb-1992 descending  
CTM3A

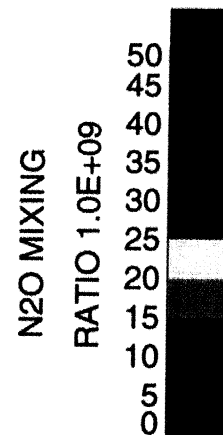
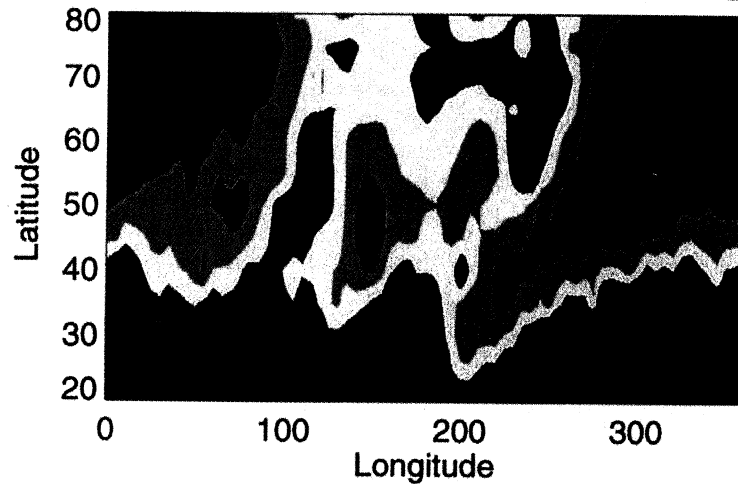


Figures 21 and 22 CH<sub>4</sub> CTM on 3.1 mb

CLAES N<sub>2</sub>O @3 hPa on 20-Feb-1992 ascending  
3AT\_CLAES\_D162\_N2O\_BASELINE\_3MB



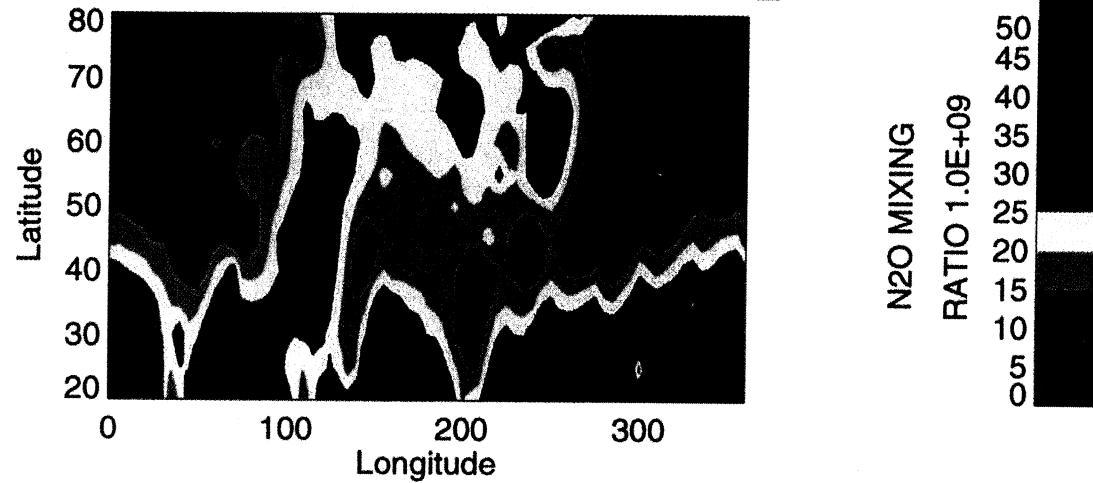
CLAES N<sub>2</sub>O @3 hPa on 20-Feb-1992 dscending  
3AT\_CLAES\_D162\_N2O\_V9NMCGRD\_3MB



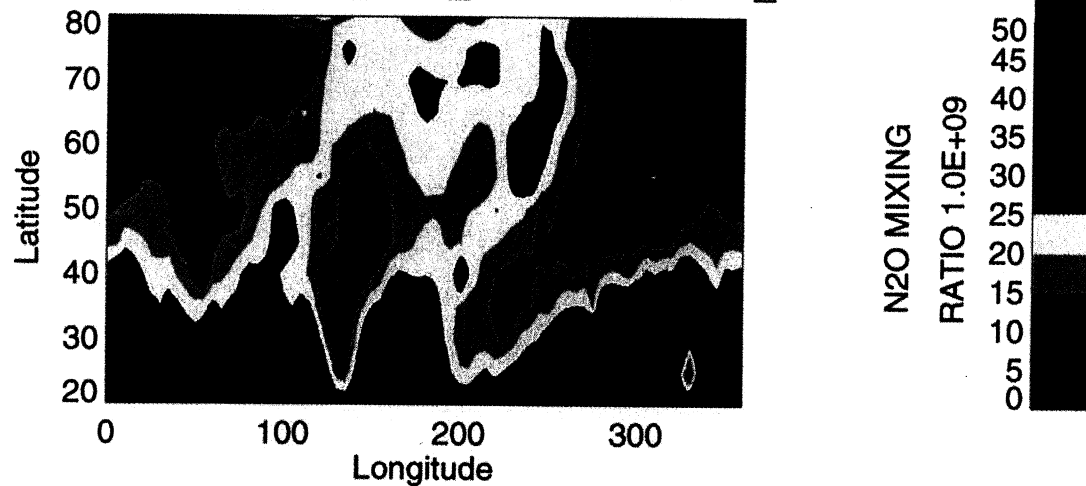
Figures 23 and 24 N<sub>2</sub>O baseline on 3.1 mb



CLAES N<sub>2</sub>O @3 hPa on 20-Feb-1992 ascending  
3AT\_CLAES\_D162\_N2O\_CTMTANDXGR\_3MB

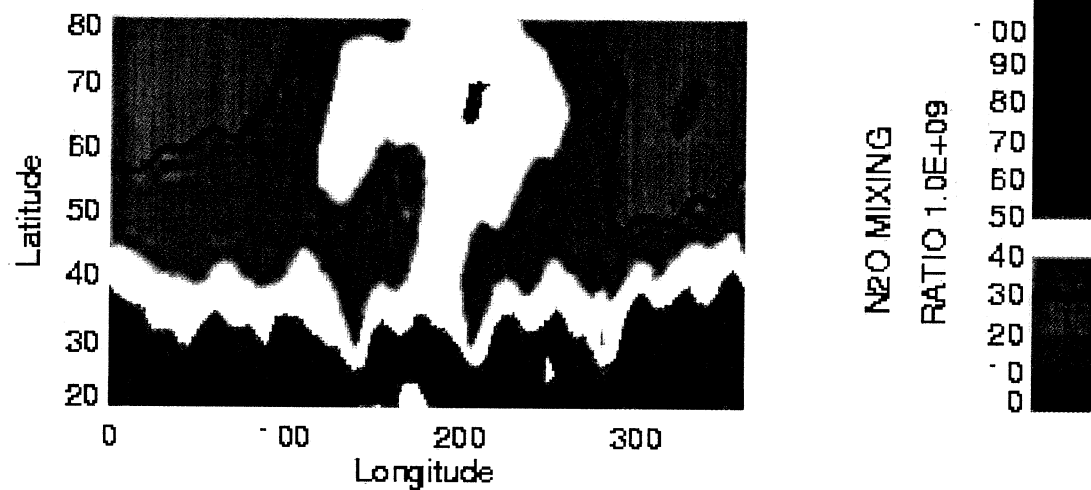


CLAES N<sub>2</sub>O @3 hPa on 20-Feb-1992 dscending  
3AT\_CLAES\_D162\_N2O\_CTMTANDXGR\_3MB

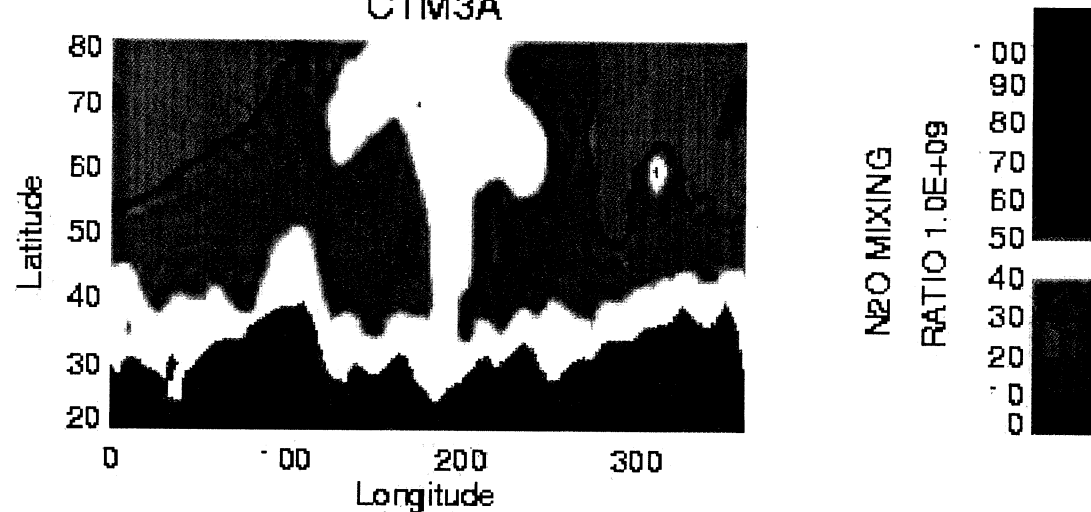


Figures 25 and 26 N<sub>2</sub>O CTMTANDXGRADS on 3.1 mb

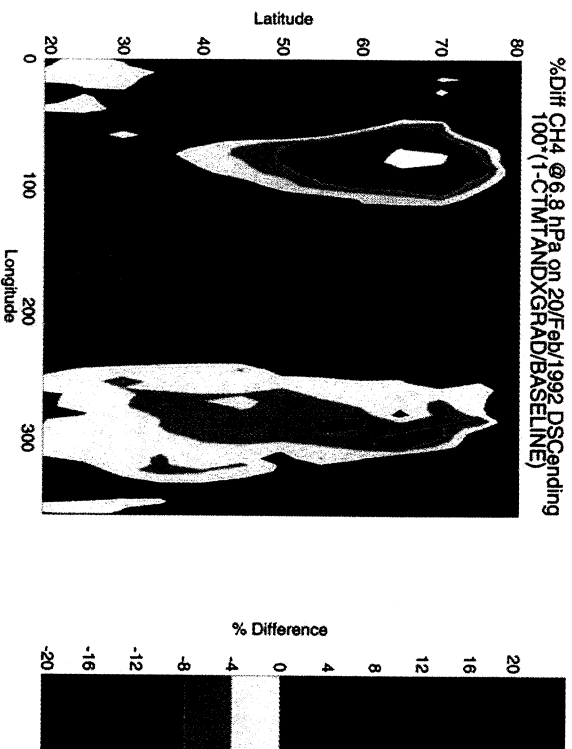
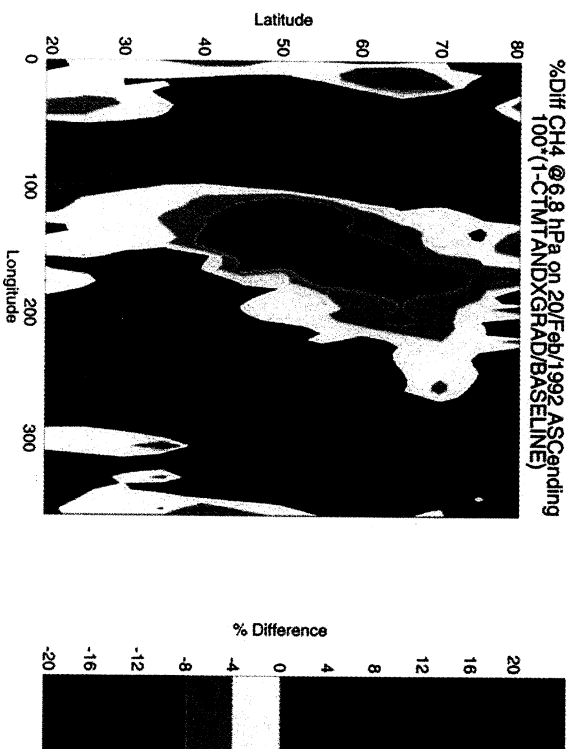
CLAES N<sub>2</sub>O @3.1 hPa on 20-Feb-1992 ascending  
CTM3A



CLAES N<sub>2</sub>O @3.1 hPa on 20-Feb-1992 descending  
CTM3A



Figures 27 and 28 N<sub>2</sub>O CTM on 3.1 mb



Figures 29 and 30 CH<sub>4</sub> ascending & descending differences of CTMTANXGRADS & BASELINE. The gradients act differently on going the 2 directions as is expected.